Synopsis of the RFCS projects for 2016
Multiscale Simulation Techniques for Metal Forming

This project aims at a breakthrough in modeling of AHSS. These steels are increasingly being used within the automotive industry but have a challenging forming behavior. An extremely fast crystal plasticity code will be used to derive macroscopically observable anisotropic plastic properties from complex 3D artificial multi-phase microstructures. This will be directly coupled to efficient Multi-Scale code, leading to numerically very efficient state-of-the-art models for forming processes of dual-phase steels. The resultant multi-scale material model will be demonstrated for realistic microstructures in an industrial FE-Code to predict product properties after forming of a large automotive part.

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The damage of a blast furnace tuyere is an incident, which happens in average 30 up to 120 times a year at normal blast furnace operation. Each single tuyere damage causes a stoppage of the whole blast furnace of about two hours, in some case up to eight hours. Although, the hot blast is stopped and no hot metal is produced, coke is consumed and additional coke has to be charged. Energy is spent without any benefit. In order to reduce the unplanned BF stoppages due to tuyere damages the objectives of the proposed RFCS project are:

- to generate advanced knowledge about tuyere damage mechanisms by analysis of tuyere material properties during tuyere life time (chronology of degradation),
- to develop advanced operational tuyere monitoring systems for monitoring of BF tuyeres during operation as industrial standard application for all tuyeres,
- to develop a BF tuyere damage risk assessment system for early detection of BF tuyere damaging conditions,
- to define practical countermeasures for BF operators to go against tuyere damaging conditions and to extend BF tuyere life time.

The decrease of the number of unplanned blast furnace stoppages due to tuyere damages enables a significant reduction of energy consumption and costs in blast furnace operation. Furthermore, it decreases the risk for the occupational health due to e. g. contact of BF staff with toxic CO gas and hot metal during tuyere exchange. Therefore, each single tuyere damage, which can be prevented, helps to increase safety of BF staff. Consequently, the proposed project contributes to the RFCS programme objectives (Council Decision 2008/376/EC):

1. New and improved steelmaking and finishing techniques
   (i) process instrumentation, control and automation
   (j) maintenance and reliability of production lines
2. Conservation of resources and improvement of working conditions
   (g) occupational health and safety
Synopsis of the RFCS projects for 2016

709434  INNOSEIS

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Valorization of innovative anti-seismic devices

Valorization actions for 12 innovative anti-seismic devices will be undertaken. The devices were recently developed in the frame of RFCS, EU and national research projects by the partners involved in the project. Information documents for all devices will be produced for dissemination to all partners of the construction sector such as Architects, structural Engineers, construction companies, steel producers and all potential decision makers of the construction sector. These documents will be bundled in a volume for dissemination. The volume will be translated in several European languages. Criteria will be set on which it may be decided which of the devices are subject to CE marking in accordance with EN 15129 and which may be considered as innovative systems that require a code approval in EN 1998-1. For the latter pre-normative design recommendations will be drafted that will allow them to receive the status of code-approved systems.

A reliability based methodological procedure to define values of behavior factors (q-factors) for building structures will be established. This procedure will be applied in turn to determine q-factors for structural systems with the anticipated devices. Case studies with application examples in which the devices are employed will be worked out. The case studies refer to new single story steel buildings, new multi-story steel-concrete composite buildings and to interventions for seismic upgrading of existing buildings. Seminars and Workshops will be organized in large parts of Europe. In addition, Seminars will be organized in non-European Mediterranean high seismicity countries to promote technologies and codes developed in Europe. A web site with free access to the users will be created and promoted to practice. Printed and electronic material will be produced and disseminated to all involved in the construction sector.

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### Synopsis of the RFCS projects for 2016

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Resource-efficient hydromechanical descaling system for wire coils

During rolling and annealing of steel, metal oxides (scale) are formed on the steel surface. The demand for further processing of steel is a scale-free surface. The achievement of a completely scale-free surface is expensive, especially for wire rod. In the forerunner project RFSR-CT-2010-00014 (HiJetRod) the great advantages of environmentally friendly high pressure water jet treatment were shown. Manually operated onsite tests have been performed with wire coils of three industrial partners. The descaling results are very good and the downstream pickling treatment of the treated coils can be reduced – the tests have shown a potential of 10% to 15% productivity increase of the pickling line. For widespread application of the new descaling process, energy and water consumption of high pressure water jet treatment have to be reduced. For this purpose, new concepts for descaling (self-induced pulsating nozzles, acid resistant equipment, innovative shape of the coil rotation equipment) as well as spent water treatment and recycling will be investigated on a laboratory and pilot scale.

For detailed evaluation of the reduction of pickling effort with the new descaling process in terms of consumables (energy, pickling acid and water), a life cycle assessment is included in the project. The industrial integration of the developed process in a pickling line by this pilot and demonstration project is completely new and innovative. It is a logical and important step to reduce the high effort required for wire coil pickling and to replace resource-intensive pre-treatment. Besides the application for so-called swab-removable scale – scale loosened in a previous pickling step – other applications for the removal of organic/inorganic deposits will be tested. Authoritative data regarding the operational and investment costs for the installation of the high pressure water jet treatment will be determined to give a basis for investment decisions of potential users.

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Synopsis of the RFCS projects for 2016

709493  DIRPRIMCOAL

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Direct Primary Coal Liquefaction via an Innovative Co-processing Approach with Waste and Petroleum Feedstocks

The main goal of the proposed research is to improve the viability and environmental performance of direct coal liquefaction (DCL) by providing a framework where it can develop in the EU without the need for extremely large-scale plant and with a focus on low-rank and perhydrous coals that provide the highest conversions at lowest cost. The research will establish a distributed approach to DCL that will enable it to be introduced as a technology suitable for co-processing a variety of wastes, including plastics, tyres and bio-wastes which can thermally decompose into effective solvents. The two primary conversion routes will be investigated to optimise the use of wastes and co-feeds are (i) the use solvents with some H-donor properties without hydrogen pressure and (ii) the use of waste and non-donor solvents with added hydrogen pressure with means for in-situ generation being investigated. The primary liquefaction products will then be assessed for co-processing with petroleum feedstocks in existing refinery facilities with a test programme involving both catalytic cracking and hydrocracking with hydro-isomerisation of the naphtha produced from both processes.

The research will identify and implement the improvements that need to be made to existing catalysts to optimally co-processing heavy coal liquids and petroleum fractions. This flexible approach will enable plants to operate on relatively small scales (ca. < 200 tonne p.d.) to provide intermediate heavy oil products suitable for further processing in existing oil refinery operations, as well as minimising CO2 emissions from co-processing a range of bio-wastes. The results of the research programme will provide the basis for designing two specific DCL modules as the basis for pilot-scale operation, based on the use of solvents with hydrogen-donor capabilities and non-donor solvents with added hydrogen pressure.

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### Synopsis of the RFCS projects for 2016

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Steel cold rolling with aqueous oilfree lubricant

Lubricants applied in cold rolling processes aims to generate high surface aspects, cooling and cleaning as well as optimisation of the tribological system. This project is focused on the targeted development of aqueous oil free lubricants (OFLs) as substitute for the conventional oil based lubricants. As result of the former RFCS-projects Optilub and Lubwork polyalkylene glycols (PAGs) have already shown comparable or even better rolling properties than conventional lubricants.

The targeted development of OFL (PAGs, Polymers) for selected cold rolling processes is central aspect of the planned work programme. One route is set for PAG based lubricants focussing the positive outcome of the former RFCS-project, the other routes are open for other promising formulation based on other type of polymers. As this constitutes a step change in the rolling process, first of all a risk assessment e.g. compatibility of the new lubricant with the existing aggregates and process fluids is required as a work basis.

Then the systematic development of oil free lubricants (OFL), their implementation, monitoring and handling measures will be covered by the project. Moreover, the impact of the new lubricant on subsequent processes will be studied in detail. The influence on cleaning, pickling, annealing and finishing will be examined too. Additionally control, care, environmental and ecological aspects will be covered as well. Based on these results OFLs composition will be continuously optimized. An equal substitute, with comparable rolling, cleaning and protective properties as conventional lubricants for both, steel cold rolling and hot aluminium rolling, will generate a massive decrease of running care, costs for replenish and disposal, over 40% cost reduction and 50% lubricant savings are possible.
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Synopsis of the RFCS projects for 2016

709526  REFOS

Life-Cycle Assessment of a Renewable Energy Multi-Purpose Floating Offshore System

REFOS is an innovative project, aiming at the development, design and life-cycle assessment of a multi-purpose floating TLP steel platform, suitable for combined offshore wind/wave energy resources exploitation. It involves a multi-discipline partnership, which covers all aspects of REFOS platform analysis and design, through a systematic, integrated and state-of-the-art approach, validated through structural and hydrodynamic testing.

The ultimate target is the final design of REFOS platform and its components, in form of a detailed design report and specific drawings, suitable for two typical locations (one in the Mediterranean and one in the North Sea) and adjustable to the environmental conditions and design requirements of a specific offshore site. The final design is accompanied by a techno-economic analysis, demonstrating the feasibility of the proposed solution. Towards this target, detailed structural analysis is performed, together with hydro-elastic dynamic analysis of the floating system, accounting for the W/T and OWC devices.

The work in REFOS continues and extends the results of a national project, where a multi-purpose floating platform, suitable for the Aegean Sea, has been studied at a preliminary stage, but without structural design considerations. The project has three phases: (a) definition of design parameters and environmental conditions at selected locations; hydro-aero-elastic analyses; air turbine design for wave energy; (b) structural design of the steel tower, platform, and tendons; mechanical testing and numerical simulations; testing of a scaled-down physical model in the Wave Tank; (C) final design & techno-economic life-cycle analysis; dissemination of results.

The proposed floating solution will constitute a breakthrough in renewable energy technology, allowing for cost-efficient exploitation of combined offshore wind/wave energy in Europe, towards new market opportunities for the steel- and the renewable-energy-industry.
709553 ROBOHARSH

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Robotic workstation in harsh environmental conditions to improve safety in the steel industry

The aim of the present project is to practically demonstrate through a real full scale installation that workers' safety protection in the steel shop can be improved by adapting an industrial robotic cell to support technical personnel in the ladle sliding gate maintenance by replacing human intervention in heavy and potentially dangerous operations. This application of robotic highly differs from the current ones in the steel field due to the adoption of a symbiotic human-robot cooperative approach in order to face very complex manipulation tasks in harsh environmental conditions.

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Synopsis of the RFCS projects for 2016

709600  PUREST

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Promotion of new Eurocode rules for structural stainless steels

This project will disseminate new design guidance for structural stainless steel which has been developed over the last 10 years, primarily arising from RFCS-funded research.

Activities are mostly targeted at design practitioners and include:

- Updating and extending the Design Manual for Structural Stainless Steel (Third Edition),
- Translating the Design Manual from English into 9 languages,
- Developing online design software and design apps in accordance with the new stainless Eurocode rules,
- National seminars,
- Recording webinars for distance learning,
- Publishing articles in national engineering journals.

Teaching resources aimed at engineering students will also be prepared.

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**ULTRA-fine austenitic stainless Steel as a Lightweight automotive Material**

The 300-series austenitic stainless steels (ASS) are an excellent choice for the automotive sector, but its use is limited by the price fluctuation due to the nickel content. Current low Ni grades of 200-series do not fully match the outstanding balanced properties 300-series steels, thus they are not considered a sound option for this sector. ULTRASLIM aims at developing ultrafine ASS – with low Ni content, high strength/ductility and good formability/weldability for the automotive industry. The new steels will be based on modifications of actual 201 ASS with an appropriate martensite thermomechanical treatment for ultrafine (< 1µm) austenitic microstructure production.

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### Towards industrial applicability of (medium C) nanostructured bainitic steels

Excellent combinations of strength and toughness can be obtained from high-carbon nanobainite, but this requires high levels of alloying and long heat treatments. This project will develop very fine bainitic – austenitic steels more cost effectively from leaner medium carbon alloys using shorter processing times via thermomechanical ausforming. Tensile strengths above 1600MPa are aimed at to give hot rolled steels with enhanced wear resistance combined with good toughness. Suitable compositions and processing parameters will be developed using modelling and physical simulation. Trial products will be produced and tested using laboratory rolled materials, and recommendations for full-scale production parameters will be made.
Continuous Performance Monitoring and Calibration of Model and Control Functions for Liquid Steelmaking Processes

The main objective of the research project is to improve, for the different stages of the liquid steelmaking process route, the continuous monitoring of the process performance as well as to ensure the permanent reliability of used dynamic process models and control rules. For this purpose, methods and tools will be developed involving the application of innovative and comprehensive performance indexes and strategies for automatic calibration of model and control parameters.

By these developments the following benefits shall be achieved for the liquid steelmaking processes:

- Improved on-line monitoring of the process performances, to be used by engineers and operators to decide about necessary countermeasures. Moreover, the increased knowledge about the process behaviour can be used to improve the operating practices.

- Long-term reliable operation of dynamic process models and rule based set-point calculations used for off-line process optimisation as well as on-line monitoring and process control, by continuous monitoring of model and control performance with automatic adaptation of related parameters (self-learning system). Results from process performance monitoring provide necessary input to the automatic calibration methods to assess the current reliability and relevance of measured data.

- Improved reliability and stability of the liquid steelmaking processes by enhanced performance of model- and rule-based control of analysis and temperature of the steel melt with reduced scatter and deviations from the desired target values.

- Minimisation of energy and resources consumption as well as treatment duration by enhanced reliability of Level-2 automation and process control functions.

The developed tools will be coupled to an integrated approach and tested exemplarily for the most important liquid steelmaking facilities of the electric steelmaking route, i.e. for EAF, LF, VD and AS plants.

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### Synopsis of the RFCS projects for 2016

**709629  FlexiCaL**

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**Development of flexible coal power plants with CO2 capture by Calcium Looping**

Coal power plants undergo flexible operation with load changes and partial load operation due to the increasing amount of renewable energy. The main objective of this proposal is to evaluate and enhance the flexibility of power plants with CO2 capture by post combustion Calcium Looping. Two novel process options (a highly load flexible plant concept and a system using an energy storage using CaO/CaCO3) are experimentally investigated at pilot scale to evaluate operational limits. Data on load changes and energy storage are used to validate dynamic system and reactor models in order to scale up efficient and flexible Calcium Looping systems.

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**Synopsis of the RFCS projects for 2016**

709669  _Cyber-POS_

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**Virtual Design of Cyber-Physical Production Optimization Systems for Long Production Factories**

Production technology in steel industry has reached a level that significant improvements can only be reached by through-process optimisation strategies instead of improving each process step separately. Therefore the connection of suitable technological models to describe process and product behavior, methods to find solutions for typical multi-criterial decisions and a strong communication between involved plants becomes mandatory.

Cyber-POS will develop a virtual simulation platform for the design of cyber-physical production optimization systems (CPPS) for long production facilities with special emphasis to thermal evolution and related material quality, leading to reduced energy consumption, shortened production time and improved product quality. Simulation and verification tools as well as a new IT framework for establishing the feasibility, safety and benefits of CPPS in the framework of “Steel Industry 4.0 Automation” will be introduced.

Process (thermal, rolling, transport) models, material-quality models, logistics/scheduling models and communication (computers, software, networks) models are merged and used for production optimization, enabling fast dynamic and flexible reaction on changes at set-points, production routes, process disturbances or interruptions.

In this project the CPPS will be implemented at two long production facilities with the focus of reducing energy consumption plus reaching shortened production times at Mannstaedt (complex profiles) and at ArcelorMittal (rails) for increasing product quality.

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Optimisation of the mixed acid online monitoring and control in stainless steel pickling plants

The European steel sector is under strong economic pressure due to the difficult global market conditions. This demands high flexible and favourable production while maintaining high product quality standards. The customized production of small lots of a wide range of special stainless steel grades distinguishes the European competitive advantage. Especially the pickling step is of high importance for stainless steel production as the product surface quality is a very essential attribute for the customers. In conjunction with the demanded high process flexibility the fast adjustment of defined concentrations in industrial mixed-acid pickling baths is of great importance for achieving consistently high product qualities and plant productivity. Available mixed acid concentration analysis techniques aren’t capable to achieve these requirements.

Thus, there is a great demand for advanced mixed acid online concentration supervision and pickling plant process control techniques. Within the RFCS project FLEXPROMUS an innovative method for continuous HF-HNO3-mixed-acid online analysis was successfully developed. First tests at two stainless steel strip pickling lines showed very promising results. However, further measuring technique optimisations are necessary to reach TRL 7. This pilot project addresses the optimisation of the innovative online concentration measuring technique concerning set-up, long-term reliability and operative range. Besides laboratory investigations and pickling process operation model developments, pilot scale tests shall be carried out at a stainless steel strip pickling line including acid regeneration, and for the first time at a wire rod plant. Finally, modernisation concepts for existing mixed acid pickling plants are to be developed. The overall goal of this pilot research project is the further optimisation of the mixed acid concentration monitoring and control in order to improve the pickling plant process operation and working conditions.
Synopsis of the RFCS projects for 2016

709711 TOOLKIT

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**Toolkit for the design of damage tolerant microstructures**

Two measures can be applied to improve the sustainability of components subjected to mechanical loads. On the one hand, materials should be used that offer the optimum balance of mechanical properties. On the other hand, a full exploitation of the offered mechanical properties should be made possible. This project addresses the first measure. It aims to provide a simulation toolkit for the computer-assisted design of damage tolerant microstructures. In detail, the project presents an approach that is made up by three steps:

1. Identification of mechanical property requirements through numerical simulations of full component behaviour. Therefore, parametric studies shall reveal the required hardening and fracture parameters that will help achieving a significantly improved structural performance.
2. Finding microstructural configurations providing the required properties. This task is based on parametric studies on statistically representative artificial microstructure models.
3. Identification of suitable processing parameters to adjust these tailored microstructures.

The project is based on the understanding that the conventional measures for mechanical property optimization have been widely exploited for many steel grades, so that tailoring the microstructure morphology is the most promising measure for future steel developments. The focus of the project lies in the development of the general method. Its applicability will only be demonstrated for two different examples. The project will bring added value in the following terms:

- Fostering sustainable component design options.
- Providing the method of tailoring steels for specific applications.
- Finding new mechanisms of material performance improvement.
- Improving the ICME approaches.
- Strengthening the position of steel products.

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**Synopsis of the RFCS projects for 2016**

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**Valueization and dissemination of technologies for measurement, modelling, and control in secondary metallurgy**

The objective of this dissemination project is to revise the most important European projects related to Secondary Metallurgy technologies carried out in the last years. The basic idea is that an action of dissemination and valorisation of the most important results, based on an integrated critical analysis, is useful to valorise, disseminate and promote the exploitation of the results. Also this action is a necessary step for preparing and communicating a roadmap for future research activities and priorities. These general objectives can be broken down as follows:

- To promote the dissemination of the knowledge gained and the technological solutions introduced in relevant projects on Secondary Metallurgy
- To identify present merits and limitations of the various technological solutions, as well as the spread of their implementation in the European steel plants.
- To identify most promising and most useful emerging development lines and to encourage the use of best results and innovative solutions, taking into account possible technological barriers

- To identify future developments, to produce a clear and realistic picture of the future trends to be expected in Secondary Metallurgy technology.
- To supply guidelines for the next developments of Secondary Metallurgy technologies, to give indications on priorities for research subjects and activities
- To suggest a clear road map for the technological development in this field.

The dissemination activities will comprise the following actions:

- Set-up of a web site to allow the access to the results of the project analysis, the presentations of seminars and workshops and the road map for future developments
- Seminars on dedicated topics
- Workshops to provide the possibility for information exchange and open discussion, especially regarding the identification of future developments and definition of a road map

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Synopsis of the RFCS projects for 2016

709741  PROMOTEE

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Functional porous carbon materials derived from coal tar for energy and environmental applications

In order to increase the viability and competitiveness of European coal tar distillation plants, it is essential that optimum use of coal-derived liquids is made. Attaining this goal implies finding ways for the revalorization of liquids that are currently of low value and are not used in high-end applications (e.g., creosotes, phenolic oils and rejects obtained from the purification of high value coal tar fractions).

To address this issue, PROMOTEE has been created as a complex European project aiming at the development of novel porous carbon materials for energy and environmental applications using low value coal-derived liquids as the carbon precursors. The following specific objectives are sought after:

- To maximize the use of coal-derived liquids as novel carbon material precursors with a view to their revalorization
- To synthesize ordered mesoporous carbons via hard-templating from creosotes and rejects
- To produce new carbon gels via sol-gel routes from phenolic oils
- To understand the effect of coal tar-derived liquids on the characteristics of the carbon materials
- To evaluate the performance of these new carbon materials in energy and environmental applications
- To assess the feasibility of industrial applications of the porous carbons and compare them with commercial carbons

PROMOTEE incorporates industrial participation from both ends of the value chain (coal tar distillers and porous carbon manufacturers) to ensure that a significant impact of the project results on relevant stakeholders is attained.

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Optimization of QP steels designed for industrial applications

Despite significant research on microstructure, strength, ductility and strain hardening of advanced high strength steels (AHSS) processed via quenching and partitioning (Q&P) in the current literature, their application related performance has not yet been studied. The present OptiQPAP proposal focuses on intelligent microstructural design in the high strength Q&P steels for simultaneous improvement of various performance and mechanical properties, which are required for their commercialization. Special attention is paid to fatigue and fracture behaviour, wear resistance, weldability, ductile-brittle transition temperature, high strain rate behavior and energy absorption, along with the formability and bendability of Q&P steels.

709755  OptiQPAP

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OpTimization of Steel Plated BRidges in Shape and STrength

Curved steel panels are increasingly used in the design of new bridges due to architectural and/or structural demands. This is a recent trend which has resulted from technological advances that allow the economical use of curved shapes. However, design rules and design recommendations for curved plated members are still scarce and fundamental knowledge needs to be developed at various levels. The main objective of this research project is to develop solid knowledge on the structural behaviour of curved and nonrectangular steel panels (stiffened and unstiffened) made of mild steel and/or high strength steel for an integrated design approach taking into account also the aesthetic impact of bridges in the LCA assessment.

The Structural Eurocodes do not cover the design of curved and nonrectangular panel segments. In fact, the scope of EN 1993-1-5 is limited to flat panels and EN 1993-1-6 is also not applicable to this type of elements since its scope is limited to shells of revolution. Design rules for curved and nonrectangular steel panels with and without stiffeners used in box-girder bridges and bridges with I-profile beams will be developed based on laboratory tests and extensive numerical parametric studies, and the following objectives will be targeted:

- Development of integrated design guidelines for the efficient, economic design of curved plated structures taking into account all relevant loading situations and design checks as well as the impact on the environment;
- To establish relevant interactions (dual flange/web role of curved cross-sections);
- To develop design rules for transverse stiffeners taking account of a possible dual flange/web role in curved panels;
- To optimize the number, shape and distribution of longitudinal stiffeners;
- To extend the plate buckling rules to plates with variable width, which are not yet in EN 1993-1-5, though they exist in bridges with curved shapes in transverse as well as in longitudinal direction.

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**Synopsis of the RFCS projects for 2016**

### 709803 NANOFORM

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**Improved formability in 3rd generation AHS steels by nanosize precipitation and microstructure control during and after hot rolling**

The goal of this project is to develop new Complex Phase Low Carbon Microalloyed Steels, by optimization of chemistry and thermomechanical processing, i.e. hot rolling and cooling, to simultaneously obtain refined microstructures and arrays of precipitate nanoparticles. The previously unexplored synergies between the elements Nb, Mo, V and Ti on precipitation before, during and after phase transformation from austenite during hot rolling and cooling will be also addressed. The project will result in new product concepts optimized with respect to processing parameter windows to give robust mechanical properties, i.e. static and fatigue strength, bendability, hole expandability and toughness.

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Synopsis of the RFCS projects for 2016

709807 LASTEICON

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**LASER TECHNOLOGY FOR INNOVATIVE CONNECTIONS IN STEEL CONSTRUCTION**

LASTEICON aims to eliminate the use of excessive amount of stiffener plates and welding in steel joints, using laser cutting technology (LCT). The project will notably enhance the economy and sustainability of the fabrication as well as the aesthetic of any type of steel joints. Major focus is given to I-beam-to-CHS-column connections to promote hollow sections, since their excellent structural properties combined with their aesthetic appeal will lead decision makers (architects, building owners) to use more steel products in the building construction sector. Extendibility of the solution to other construction applications will be investigated with reference to steel truss girders.

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Synopsis of the RFCS projects for 2016

709816  StackMonitor

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Online Blast Furnace Stack Status Monitoring

The decreasing and fluctuating quality of raw materials and the aim to maximise PCI and decrease coke rates force European blast furnaces to operate closer to operational limits. At same time productivity and efficiency must be raised to survive in global competition. High stack permeability and stable gas distribution become most important. However, the analysis and control of the stack processes is difficult: Hundreds of measurement values are available nowadays, but they are distributed around the blast furnace and just show indirect “fingerprints” from outside instead of the real internal process information needed (e.g. position of process zones). New measurement techniques deliver very fast, full 2D information of the top (acoustical gas temperature, burden profile radar), but they are not sufficiently validated and not investigated by research. Instead, the operators are overcharged with even more separate measurement data. No overall process information is available to decide about control actions.

The main idea of StackMonitor is to establish a new hybrid approach of data processing which couples statistical and kinetic process models with several online measurements. This new approach will provide industrial benefit even beyond iron making, since several industrial processes suffer from the mismatch between the vast amount of measurement data and its poor exploitation.

To achieve this aim, StackMonitor establishes the innovative coupled CFD-DEM simulation to support online process monitoring and control, validated with comprehensive high temperature lab trials. Thus, for the first time the interrelations between solids and gas in the upper stack can realistically be described: The percolation, mixing and degradation of material during descent and the corresponding layer permeability.

Online tools for process monitoring, analysis and control are developed and validated in collaboration with three industry partners covering different operational conditions.

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## Ultrafine grained steel long products by Multi-Pass Warm Caliber Rolling Technology

The aim of this project is to produce submicron ultrafine grain (UFG) long steel products (ferrite-cementite microstructure) with high strength and adequate ductility for automotive and mechanical applications that can be further processed by cold forming or direct machining.

The idea consists in producing UFG bars by multi-pass warm caliber rolling in the temperature range 500-700°C, exploiting as refining mechanism the dynamic recrystallization or recovery of ferrite induced by accumulation of strain during multipass deformation.

The focus will be on medium and high carbon steels.

The medium carbon steels are currently used in the manufacturing of automotive component and in this case the development of ultrafine microstructure can lead to improvement in strength and toughness and, accordingly, to a subsequent improvement of dynamic properties, as fatigue resistance and a higher reliability of safety components with direct impact on vehicle safety.

About high carbon steels, a problem of using them for engineering applications is the fact that toughness deteriorates due to the high carbon content. Grain refinement is a method of improving toughness and strength simultaneously and could allow the use of high carbon steels for mechanical applications where high toughness levels are required.

While previous research, both at European and worldwide levels, has been focused on validation of UFG technologies at laboratory scale, MILDROLLING project approach is extending validation to semi industrial scale in order to determine its industrial feasibility, to state mechanical properties of UFG steels for further processing and to establish the influence of those processes on grain size stability, aiming for a practical application and quick transferability to European car-making industry of UFG long steel products.
**Synopsis of the RFCS projects for 2016**

**709830  SHELL-THICK**

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**Improvement of the continuous casting through a new system for the real-time measurement of SHELL THICKness in several locations of the casting strand**

SHELL-THICK project aims at developing an innovative induction tomography system for metal solidification process. It provides a real-time and reliable measurement of the shell thickness in three billet cross-sections in the final region of the strand and the value of the metallurgical length for a better control of the process. Based on this information, the project will also implement a tool for the on-line and non-destructive detection of different surface defects and potential fails in the process. This will introduce a step change in solidification process with significant benefits in terms of quality, safety, productivity, costs and ultimately of competitiveness.

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Controlling austenite stability by substitutional alloying elements in QP route

This proposal presents a new high temperature Quenching & Partitioning (Q&P) treatment where the stabilization of austenite is achieved not only by C diffusion but also by the diffusion of substitutional alloying elements. This innovative idea opens an unprecedented approach to produce martensite – austenite microstructures, which is expected to lead to a new 3rd generation advanced high strength steel family with enhanced formability. Investigations will combine advanced experimental techniques and the formulation of new models. It will lead to understand the partitioning behavior of substitutional elements in Q&P route and to determine the TRIP effect that an austenite stabilized by substitutionals can originate.
Co-processing of coal mine and electronic wastes: Novel resources for a sustainable future

CEReS aims to introduce a series of technological improvements to reduce the risks associated with managing existing and future coal production wastes. Virtually all European coal miners have to manage AMD production when processing coal with relatively high sulfur content; to be able to maintain economically viable production they must adopt sustainable solutions for their wastes. CEReS will develop a generic technological approach for AMD generating wastes. The co-processing approach proposed by CEReS employs AMD-generating coal production wastes as a cheap source of leaching solution (lixiviant) to recover metals from e-wastes. The novel flow-sheet will (i) remove the AMD-generating potential of coal wastes, ensuring their long term environmental stability while expanding avenues for their safe reuse; and (ii) enable selective recovery of base metals from waste PCBs, while concentrating precious and critical as well as rare earths into enriched substrates.

Compared to best available technologies CEReS has numerous economic and environmental benefits by bringing together two waste streams from opposite ends of the supply chain; harvesting each as a novel resource for a single, coherent ‘grave-to-cradle’ process.

CEReS will use Poland as a case study region and will select and characterise suitable acidogenic coal wastes and obtain PCBs from regional e-waste processors. A cross-mapping exercise will identify the extent to which CEReS can be applied across the entire EU. A bioleaching circuit will be developed and optimised for acid and ferric iron lixiviant production and reuse options for leached residues elaborated. A PCB pyrolytic pre-processing step will be optimised, producing a metal-rich char. A char leaching reactor system will be developed to leach the metals using the biolixiviant from the coal wastes. These processes will be proven at lab (mini-pilot) scale and integrated through modelling and simulation to demonstrate the viability of the CEReS concept.
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Synopsis of the RFCS projects for 2016
Overall-Slenderness Based Direct Design for Strength and Stability of Innovative Hollow Sections

In order to meet the increasing demands for sustainable & economic constructions, the European steel industry sees the increased use of more thin-walled sections and/or higher-strength steel grades as a main industrial goal. However, this leads to a number of scientific and engineering challenges, which stem from greatly increased relevance instability phenomena, as well as from the lack of appropriate design rules for slender, high-strength hollow sections. This project intends to address these points:

1) "Direct" design rules for the cross-sectional strength of hollow sections will be developed, on the basis of the “Overall Interaction Concept”. The method will lead to a continuous strength function for the class 1 to 4 range and take advantage of beneficial effects (mutual restraint, real stress state, strain hardening, …).

For CHS and EHS in particular, the new method will fill the current gap in design rules for class 3 and 4 sections.

2) The method will be expanded for the applications in beam-columns and interactive L-G buckling.

3) The elastic buckling behaviour of hollow sections will be studied in a systematic, (semi-)analytical way using the Generalized Beam Theory.

4) The safety level of the new design rules will be ascertained on the basis of the methodology of EN 1990, making use of the test data provided in the project (physical and numerical tests) as well as production data regarding material properties and geometric tolerances provided by the industrial partners.

5) The fields of application and of product improvement will be studied by R&D and engineering representatives of major steel industry stakeholders. Case-studies of structures built using traditional design rules will be re-assessed to determine the economic and technical advantages of the new design rules and developments in steel grades, shapes, and wall thicknesses.

6) Specific design guidelines and tools (software) will be developed and made available to the industry.

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Synopsis of the RFCS projects for 2016

### 709920  ReduWearGuid

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#### Reduction of wear on guiding components in hot strip mill

The hot strip mill for flat products is still key part in the steel strip production. During the last decades, the plants were optimised and became more and more effective. Intensive work was done especially on the key process steps like mill stands, cooling sections, etc. Nevertheless some parts of the plant were not that much focused, like the guiding components.

The project ReduWearGuid is aimed at reducing the wear on guiding components used in hot rolling mill (pinch roll, side guides, conveyor rolls) by the application of new type of lubricants, wear protective coatings or wear resistant materials for the guiding components. The main requirements for these guiding components are high resistance against abrasive and adhesive wear, thermal impact and corrosion.

The increase of wear on the guiding components is a real problem because it induces:
- Plant downtimes for maintenance / repair / exchange of guiding components,
- Unnecessary downtimes due to unharmonised lifetime of the guiding components,
- Material defects caused by damage or by sticking of material,
- Lower product dimensional tolerance (damage on strip edge, etc.).

In order to develop individual solutions to reduce local mechanical and thermal wear, a multi-disciplinary approach will be used based on state-of-the-art characterisation, laboratory testing, modelling and production trials. The main objectives are the increased life time of guiding components, the reduction of production costs and downtimes and the reduction of surface defects on the strip.

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## Synopsis of the RFCS projects for 2016

### 709923 OSCANEAF

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### On-line slag composition analysis for electric arc furnaces

Electric steelmaking has fast gained ground in developed countries due to reduced CO2 emissions compared to blast furnace steelmaking and better production flexibility. Due to increased scrap usage, the quality of the scrap is getting worse and worse. This is reflected in the increase of non-metallic material in the scrap. Fluctuations in EAF scrap charge composition causes significant fluctuations in the EAF slag composition, since the non-metallic material in the scrap accumulates in the slag.

Fluctuation of slag composition causes many challenges in EAF steelmaking. In stainless steelmaking one of the most important goals in EAF is to keep the chromium content of the slag low, since it causes costs due to increased alloying additions and problems in recycling of slag. In carbon steelmaking it is important to ensure foaming slag conditions, which increases energy efficiency of the EAF. Due to the slag composition fluctuations the slag foaming is sometimes hindered when the slag composition drifts to the composition area with low foamability.

There are currently very few methods available for analysing slag composition in EAF. One of the most popular methods to gain information of slag composition is taking slag samples and analysing them in laboratory. Currently there is no method available to analyse slag composition in industrial EAFs on-line.

The objective of the proposal is the development of a continuous measurement system for EAF slag component analysis based on optical emission spectroscopy. The aim for stainless steel grades is the analysis of Cr2O3 and MnO content, while for carbon steel grades the aim is to analyse CaO, SiO2, Al2O3 and MgO content of the slag. The proposed technology will follow these criteria:

- remote and continuous measurement system for slag component analysis,
- low maintenance system design,
- optimized operating practices based on continuous slag composition data increasing resource and energy efficiency.

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Optimizing the toughness of high strength steel weld metal

For many steel constructions, high toughness of welds is a critical parameter to meet with current safety standards. For some high strength steel grades, HSS, the required weld metal toughness can be hard to reach due to non-uniform metallurgy achieved by means of standard welding techniques. Heterogeneous distribution of alloy elements of the wire filler metal into the weld seam, together high dilution levels, can lead to poor toughness in conventional welded HSS. For conventional laser arc hybrid welding, LAHW, of thick HSS plates, in addition, the narrow laser welding gaps associated to narrow-and-deep penetration hybrid welds limit the penetration of the elements added by the filler wire and, thus, the attainment of homogenous element distribution along the hybrid weld. As a consequence, scattering of the toughness data is obtained when testing at low temperature, down to -60º C.

In the OptoSteel proposal, a novel experimental and simulation-based approach, combined with extensive toughness testing and a detailed metallurgical characterization of welds, will allow defining the new welding strategies and procedures, including filler metal development, aimed at ensuring homogeneous filler material distribution across the weld metal. This will lead to optimized weld metal toughness, enabled by using advanced laser welding techniques and methods, which are non-conventional LAHW and narrow gap multi-layer laser welding with wire addition, NGMLW.
### Synopsis of the RFCS projects for 2016

#### 709954  DP700-Phase 1

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**Preparation for Commercial Demonstration Plant for 700°C Operation**

PF-fired hyper super critical (HSC), also known as advanced ultra super critical (A-USC), power plant is able to reach 50-55% net (LHV) efficiency thereby decreasing the specific power plant CO2 emissions; however HSC plant development entails large technical and commercial risk. This project aims to bring together EU knowledge and experience on high temperature boiler materials and components suitable for HSC operation, thereby reducing these risks.

This consolidation of knowledge will lead into the design, build and operation of a full scale 1000MW demonstration plant, under a follow on project, allowing EU companies to have a head start in these new markets.

Phase 1 is the knowledge capture phase with Phase 2 being the design build and operation of a full scale 1000MW demonstration plant. Phase 2 will be subject of a follow on project from this Phase 1 project.

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Synopsis of the RFCS projects for 2016

709962 Duramech

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Towards Best Practice for Bolted Connections in High Strength Steels

The main goal of the proposed DURAMECH research project is to understand, predict and ultimately increase the fatigue resistance of bolted connections in moderately thick high strength steel materials, used in applications for heavy machinery.

By combining a substantial experimental effort with advanced numerical methods, the fatigue properties of these joints will be assessed and compared with welded solutions that typically have a much lower fatigue resistance. At the same time, design guidelines and best practice modelling techniques for these types of connections will be derived. During the project the results are applied to relevant cases supplied by the end users.

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Synopsis of the RFCS projects for 2016

## 709976 NIBALO725

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### Ni-based alloys for Operation of 725 °C Power Plants

In order to further increase the efficiency of coal fired power plants and reduce emissions higher steam temperatures and materials with improved mechanical properties under high temperatures are required. Aim of the project is to implement Ni-based alloys in coal fired power plants in order to obtain maximum steam temperatures of > 700 °C in the steam cycle. A numerical assessment of stresses and material investigations of small and large scale specimen will be performed. A field test in a 725 °C test rig (GKM Project HWT III) will demonstrate the feasibility of the implementation of these materials.

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Synopsis of the RFCS projects for 2016

**710040 REDUCE**

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**Reuse and demountability using steel structures and the circular economy**

The project will provide methodologies, tools and guidance to assist in design for deconstruction, particularly of composite steel structures for multi-storey buildings. This will lead to new shear connection systems for demountable composite construction, based on push tests and beam tests to verify composite action and to develop design rules. The whole life benefits of reusable structures will be quantified using LCA and circular economy indicators. Opportunities for greater standardisation and the use of BIM will be explored to facilitate deconstruction. A demonstration of demountability of the developed system is planned. Guidance on design for deconstruction and reuse will be prepared.

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### Synopsis of the RFCS projects for 2016

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### Drones for autonomous monitoring of steel plants

Aim of this proposal is to evaluate the benefits arising from the application of Unmanned Aerial Vehicles (UAVs) in steelworks. So far UAVs have been deployed for military applications or used in small but growing number of civil applications, but never systematically in the steel industry. The goal is to substitute men in complex and expensive operations as those related to the monitoring, maintenance and safety of steel plant infrastructures. The implementation of real use cases with autonomous flight in two steel plant (TKSE, ILVA) and the experimental feasibility for indoor applications will prove the benefits deriving from UAV technology.

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Synopsis of the RFCS projects for 2016

710068  SBRIplus

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Valorisation of Knowledge for Sustainable Steel-Composite Bridges in Built Environment

Within the previous RFCS research project SBRI “Sustainable Steel-Composite Bridges in Built Environment, a holistic approach was applied to steel-composite bridges by combining analyses of environmental, economic and functional qualities along the entire life-cycle of bridges. This proposal aims at the valorisation, the dissemination and the extension of the developed method for Advanced applications. A wide audience including bridge engineers and authorities should be reached, in order to assure the application of the project outcome.

Main tasks:
- Explanation of methodology and background by elaboration of worked examples and improvement of the SBRI-tool
- Extension of bridge types by advanced application to innovative bridges across Europe demonstrating the flexibility and applicability of the methods developed
- Dissemination activities (11 European languages, addition of national regulations and practices, organization of 13 workshops)
- Providing of recommendations for advanced applications and guidelines for bridge authorities.

Two design manuals will be prepared, drafted and translated in 11 European languages (CZ, EN, ES, FR, HR, DE, IT, NL, PT, PL, RO, SW) and distributed within the planned dissemination activities. Design Manual I includes background information on the methodology and worked examples for easy application in daily design work with the help of the improved software tool. By analyses of built examples across Europe the SBRI method is applied to innovative bridge solutions, results and conclusions are shown in Design Manual II. Another important task is providing of recommendations summing up and concluding the analyses and being the bases for guidelines to be elaborated for bridge authorities. The seminars around Europe offer the opportunity to present not only the results of the SBRI project, but also the advanced application to innovative solutions in addition to national regulations and practice.

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### Synopsis of the RFCS projects for 2016

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Synopsis of the RFCS projects for 2016

710078 INNOWATREAT

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The innovative system for coke oven wastewater treatment and water recovery with the use of clean technologies

Cokemaking industry generates huge amounts of wastewater contaminated with a range of contaminants. Those streams contain substances, which are of classified as priority substance and priority hazardous substances due to European Water Framework Directive. Hence, their proper treatment and management is crucial for protection of aquatic systems, to which they are usually discharged. The main aim of the INNOWATREAT project is the development of the complex system for coke oven wastewater characteristics, treatment and utilization. The project programme includes testing of analytical procedures, adaptation and development of a range of wastewater treatment methods and investigations on water recovery by means of clean technologies.

Moreover, computational approach of the elaborated technological solutions as well as economic and environmental feasibility studies are involved to the project objectives. Project consortium comprises of partners, who possess wide experience and knowledge on the field of cokemaking, coke oven wastewater characteristics and wastewater treatment and utilization methods. The main principals of the project are elaborated on the basis of multiple consulting with cokemakers and coke oven wastewater treatment plants operators in order to approach the issue with the highest attention and further implementation to the industrial systems.

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